Contaminant Report Number: R6/118K/03

U.S. FISH & WILDLIFE SERVICE
REGION 6
CONTAMINANTS PROGRAM

CONTAMINANT PATHWAY ASSESSMENT FOR PIPING PLOVERS ON NATIONAL WILDLIFE REFUGE LANDS IN NORTH DAKOTA

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Project #98-6-6N38

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June 2003

TABLE OF CONTENTS

INTRODUCTION

North Dakota is one of the last strongholds for the Federally threatened piping plover (*Charadrius melodus*). Protecting and enhancing plover habitat in North Dakota will play an important role in recovery of the species (Piping Plover Recovery Team, unpublished report 1996). Much of the plovers' breeding habitat in North Dakota is found on the U.S. Fish and Wildlife Service's 1,100 Waterfowl Production Areas (WPA).

WPA's used by breeding piping plovers in North Dakota are typically small disjunct pieces of property ranging in size from 16 to 400 hectares and are usually surrounded by cropland. Because of their small size and the close proximity of agricultural land to their boundaries, wetland habitats on WPA's are vulnerable to pesticides used on adjacent cropland (Grue et al. 1988).

Numerous studies have documented pesticide impacts and threats to wetlands in cropland (Facemire 1993, Facemire 1990, Brewer et al. 1988, Johnson 1986, and Sayler and Trevor 1985). Insecticides that enter wetlands can have direct toxic effects on invertebrates (plover food base), and subsequently may indirectly affect plover survival by altering available forage. Applications of methyl and ethyl parathion to North Dakota wetlands resulted in the mortality of most aquatic invertebrates in study wetlands with effects persisting up to 18 days post-spray (Borthwick 1988). Grue et al. (1988) also found that ethyl parathion applied to cropland adjacent to wetlands in North Dakota significantly reduced aquatic invertebrates. Macek et al. (1972) documented a 75 percent reduction in insect populations of caddisflies, mayflies, and midges in shallow ponds after the application of chlorpyrifos, and Odenkirchen and Eisler (1988) recommended restricted use of chlorpyrifos in wetlands and agricultural use in watershed areas because of its effects on nontarget biota.

One method of protecting plovers from pesticide impacts is the North Dakota Endangered Species/Pesticide Management Program. North Dakota was the first State in the Nation to implement an Environmental Protection Agency-approved Endangered Species/Pesticide Management Program. This Program is administered and implemented by the North Dakota Department of Agriculture (NDDA), North Dakota Game and Fish Department (NDGFD), North Dakota State University Extension Service (Extension), and U.S. Fish and Wildlife Service (Service). The Program is designed to protect federally listed species from pesticide contamination while reducing undue restrictions on agricultural producers. A 1989 Biological Opinion prepared by the Service identified 22 pesticide active ingredients with potential adverse impacts to threatened and endangered species breeding in North Dakota (Table 1). County maps depicting locations of endangered species are distributed to certified commercial pesticide dealers and applicators. On the back of each map is a list of the 22 pesticides that cannot be applied within or adjacent to the endangered species habitats delineated on the maps without first consulting one of the partner agencies. The consultation assists with determining if, when, and/or how the pesticides could be applied in a manner that protects endangered species. However, the county maps are often insufficient, due to the small scale and lack of detail, in

identifying specific cropland areas adjacent to sensitive habitats where the listed pesticides can or cannot be used. This leads to confusion and frustration for the landowner and partner agencies. Compounding this frustration is the fact that we do not know specific pesticide pathways to wetlands associated with specific Service lands, or vulnerability of pesticide exposure to listed species utilizing wetlands on those Service lands.

Table 1. Pesticide active ingredients having use restrictions near threatened and endangered species habitats in North Dakota.

Aldicarb	Ethyl parathion
4-Aminopyridine	Fenamiphos
Azinphos-Methyl	Fensulfothion
Carbaryl	Fonofos
Carbofuran-granular	Isonfenphos
Chlorpyrifos	Methyl parathion
Diazinon	Mevinphos*****
Dicrotophos	Oxyamyl
Disulfoton	Oxyfluorfen
Endosulfan	Paraquat
Endrin-granular*****	Phorate-granular
Endrin-nongranular*****	Toxaphene-nongranular*****
EPN*****	Trichlorfon
Ethoprop-granular	

***** Canceled pesticide

Geographic Information System (GIS) technology offers a powerful tool for identifying and assessing spatially related pesticide pathway characteristics of the landscape (e.g., topography, vegetation, soils, land use, etc). Generally, GIS processes use numerous "layers" of data to develop spatial data bases and generate maps that can be used to determine where specific landscape features are positioned and identify where multi-layers interact in specified fashions. Assessing vulnerability of plovers to pesticide exposure will involve inventorying and ranking of pathways. Certain habitats will have a greater probability of receiving contaminants because of pathway characteristics, such as soil type, proximity, topography, land use, etc. Chemical characteristics (e.g., persistence, mobility, solubility, etc.) also play an important part in assessing potential pesticide contamination. Satellite imagery, specifically thematic mapper data, combined with National Wetland Inventory data will allow a GIS application that can assess and identify endangered species habitats on Service lands, with the greatest vulnerability to pesticide contamination based on landscape and chemical characteristics.

This On-Refuge investigation delineates habitat for threatened and endangered species on U.S. Fish and Wildlife Service lands, identifies pesticide pathways to those habitats, and assists private and public landowners in their efforts to protect these areas from harm caused by pesticides. Also, this project provides a spatial data base of land use and endangered species habitat coverages, which is updated on a continual basis as some of these species pioneer into new habitats. The results of this investigation provide a readily usable, up-to-date data base to assist land managers with management decisions.

METHODS

Arc/Info and ArcView software (ESRI, Redlands, California) was used to develop and manage all digital feature and attribute data. The coordinate system utilized in this project was Universal Transverse Mercator, Zone 14 NAD27 with North America Datum 1927.

Point, polygons, or line segment locations of piping plover habitat were buffered 0.5 miles to represent the focal area. Digital themes of relevant spatial data were developed for the focus areas. Digital Orthophoto Quarter Quad (DOQQ) imagery (≈/m resolution, photo date 1991-2001) was used as a backdrop for display purposes.

Initial data layers compiled in this study included: base layer of point, polygon, or line segment locations of breeding habitat locations; National Wetland Inventory digital data; transportation; public land survey; Digital Elevation Model data; Natural Resources Conservation Services SSURGO soil data; ownership data and DOQQ imagery. Additional data developed from these layers included watershed and surface water runoff pathways.

A predictive model developed by Seelig (1998) was used to assess the potential for surface water contamination from pesticide use. Six factors are incorporated into this model: surface water proximity; pesticide formulation-application; pesticide/solution interaction; pesticide/sediment interaction; land slope; and flooding frequency. Several researchers have demonstrated that a pesticide's ability to move off-site is influenced by the characteristics of application, formulation, chemistry, and soils (Cara. 1976; Wauchope, 1978; Leonard, 1990; Baker and Johnson, 1983; Rao et al., 1983; Christensen et al., 1993; Larson et al., 1997). Using our GIS, we applied the model to each of the active ingredients listed in the Endangered Species/Pesticide Management Program.

Once the spatial data base and cover layers were created, they were used to depict interactions of specific landscape features in relation to modeled pesticide-movement potential. Management priorities could then be assigned to Service lands based on vulnerability of plover habitats to pesticide contamination in association with habitat use, pathways, watershed, land cover, etc. High resolution maps depicting specific pathways and areas of concern have been produced and incorporated into Endangered Species-Pesticide County Maps.

RESULTS

This investigation shows how a GIS can use soil and chemical properties to model pesticide movement into endangered species habitats. Custom programming of a GIS was used to create an interactive program which allows users to locate endangered species habitats, select from a list of restricted use pesticides and thus produce a ranked, visual representation of the selected pesticide's potential of moving into an endangered species' habitat. The investigation also provides other spatial data (watershed, stream, elevation, etc.) to provide a greater level of detail and pinpoint contaminant pathways. This GIS allows for quick determination of potential for a contaminant to reach endangered species habitats. This tool also helps producers, regulators, and land managers develop a comprising strategy of pesticide use and land management within endangered species use areas.

The following is a demonstration of the interactive model and it's applicability.

DISCUSSION

Land managers and pesticide applicators can now make informed decisions. Information in the GIS can lend support to an applicator's decisions, such as which areas to avoid when applying chemicals, spot-treatment vs. whole-field applications, specific areas to avoid when mixing or rinsing, and whether alternative chemicals should be used.

The GIS provides another tool for the Service's Partners For Wildlife Program. The level of detail in the GIS enables biologists to target specific contaminant pathways for preventative management. Specific management actions (grassed waterways, buffer strips, crop residue management, and alternative land uses such as forage) are now targeted directly at the most problematic areas.

Information developed in this study also assists Service land managers with identifying pathways for contaminants other than pesticides that are entering Service lands. Continually changing coverages developed through GIS will serve as a source of information for refuge planning documents, and assist with development and implementation of contingency plans and emergency spill response.

The following image is a DOQQ showing a wetland that supports breeding piping plovers, and the boundary of a Service Waterfowl Production Area. Quarrying just the drainage patterns alone is enough to assist land managers with decisions regarding specific pathways.

We have determined an effective tool in disseminating the GIS tool to both pesticide users and land managers is through the Internet. Because of its flexibility and potential for providing pesticide users with timely and current information on listed species, habitat, and necessary protective measure, White et al. (2001) also advocate use of the Internet to disseminate Endangered Species/Pesticide Management Program maps. The GIS is to be housed on the Service's North Dakota Field Office web home page, and be accessible via links on the ND Department of Agriculture, State Game and Fish Department, and North Dakota Agricultural Extension web sites. Currently the U.S. Department of Agriculture's Natural Resource Conservation Service has recently switched attribute data sources for SSURGO soil data. The new data base will provide a wealth of information. However, the switch will require revision to the programming for our Endangered Species/Pesticide Management project before it can be fully functional on the internet.

The results of this investigation have been presented at the Service's Region 6 GIS workshop in 1999, and the 9th Annual Conference of The Wildlife Society, 2002, Bismarck, North Dakota.

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